Bell Work
28-April-2014

What is the pH of a 1.75M solution of NaOH?   What does pH stand for?

Agenda

Galvanic Cell

Objective:

You will know what a galvanic cell is and it parts!

Electrochemistry

Applications of Redox Rxns and Electricity

Review

Oxidation reduction reactions involve a transfer of electrons.

Oxidation Involves *<u>Loss</u>* of electrons (charge goes up)

Reduction Involves *<u>Gain</u>* of electrons (charge goes down)

Review

I. What is the reducing agent?

II. What is the coefficient in front of water in the *balanced* equation below?

$$Ag + Cr_2O_7^{2-} + H^+ \rightarrow Ag^+ + Cr^{3+} + H_2O$$

Applications

Moving electrons is electric current.

$8H^{+} + MnO_4^{-} + 5Fe^{+2}$
$\rightarrow Mn^{+2} + 5Fe^{+3} + 4H_2O$

Helps to break the reactions into half rxns.

$\mathbf{8H^{+} + MnO_4^{-} + 5e^{-} \rightarrow Mn^{+2} + 4H_2O}$

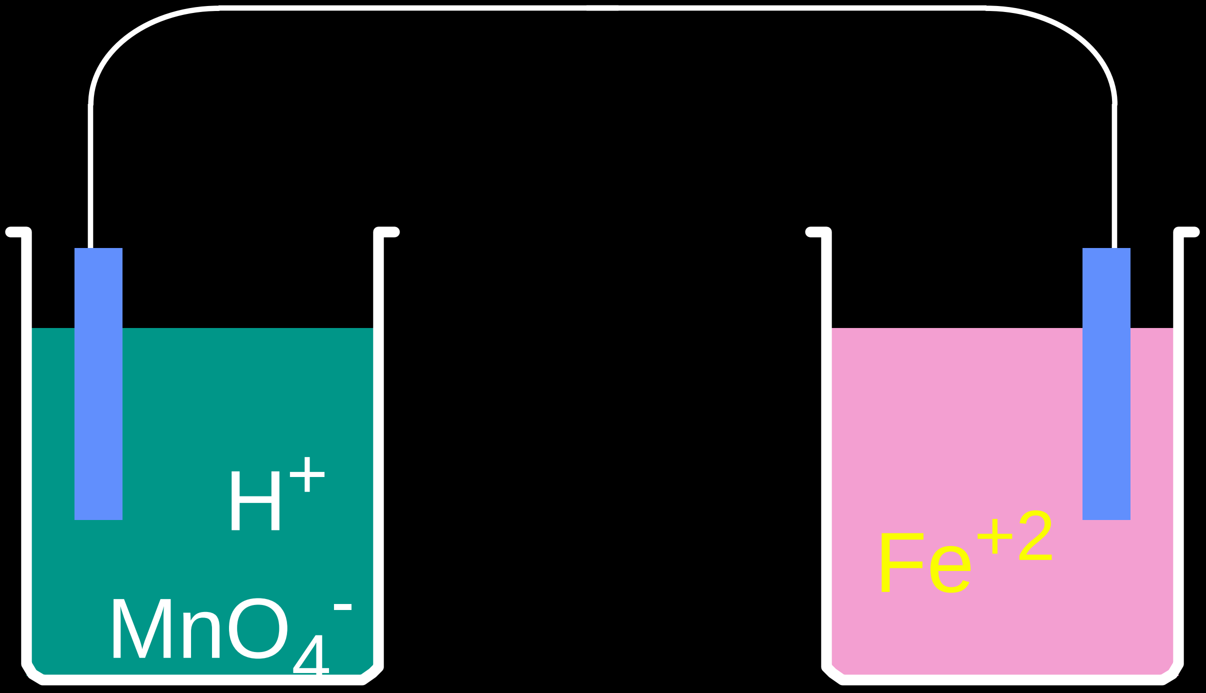
$\mathbf{5(Fe^{+2} \rightarrow Fe^{+3} + e^{-})}$

In the same mixture it happens without doing useful work, but if separated… we can do work

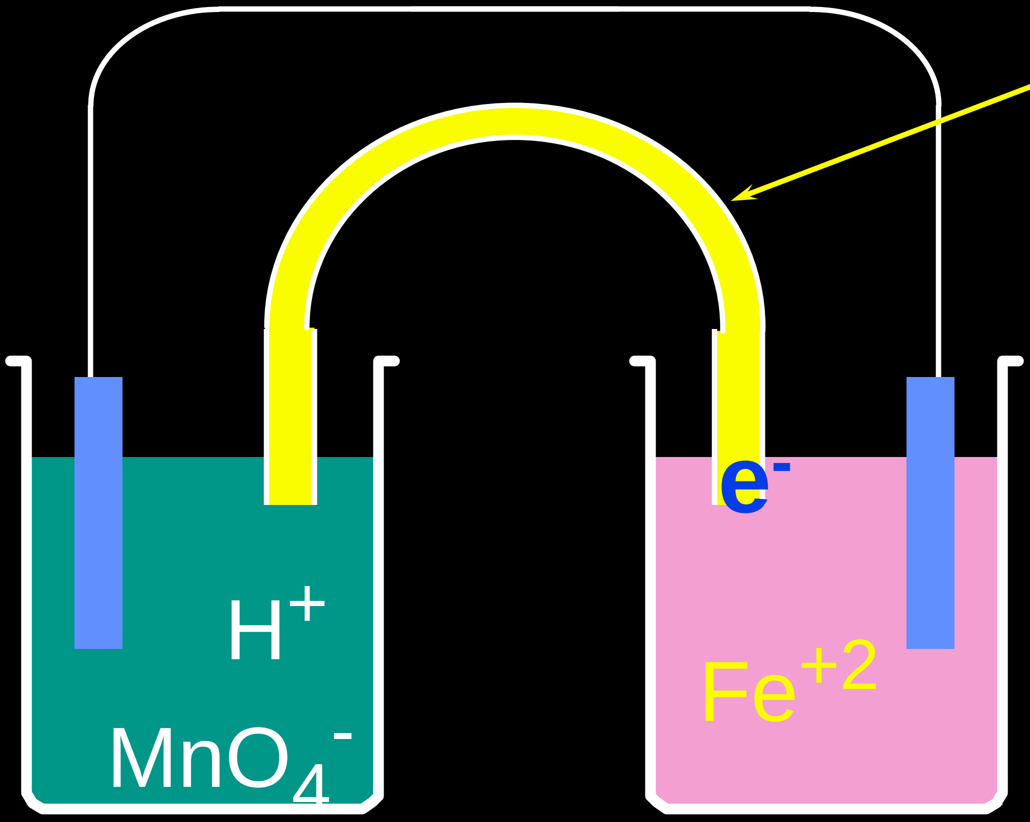
Galvanic /Voltaic Cell

Connected this way the rxn starts

Stops immediately because charge builds up.

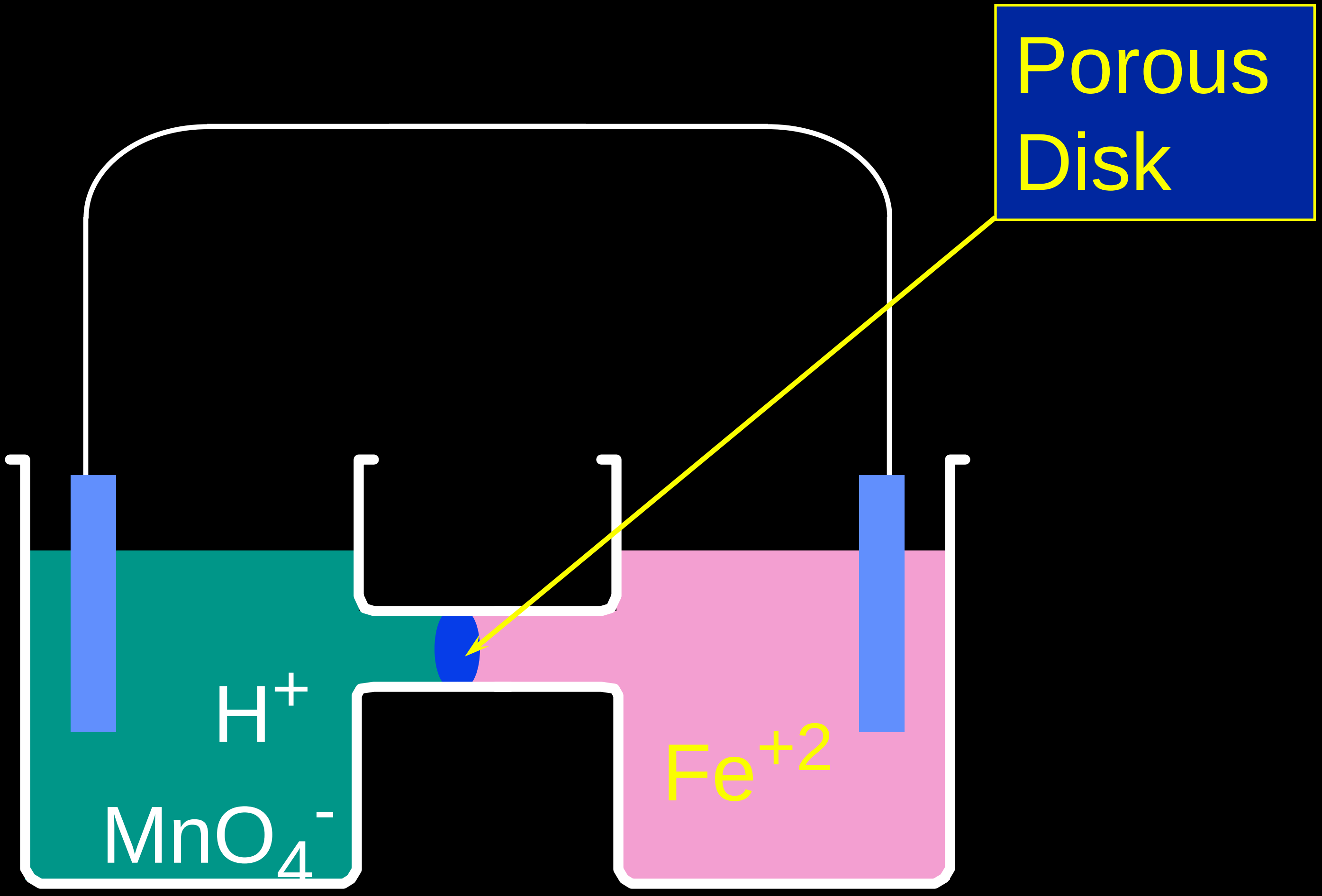


Galvanic /Voltaic Cell

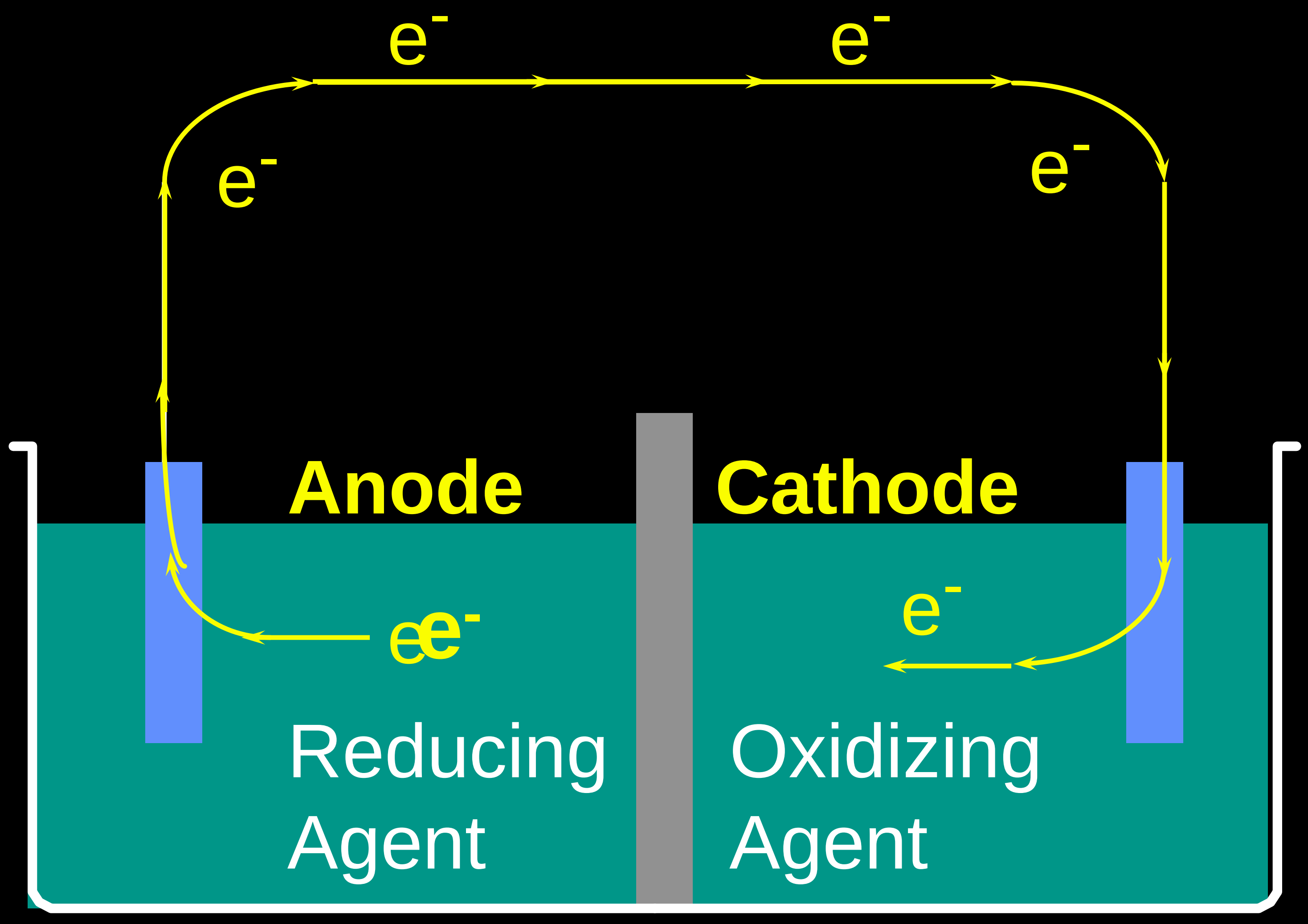


Salt Bridge allows current to flow

Galvanic /Voltaic Cell



Galvanic /Voltaic Cell



Cell Potential

Oxidizing agent pulls the electron.

Reducing agent pushes the electron.

The push or pull ("driving force") is called the cell potential; E_{cell}

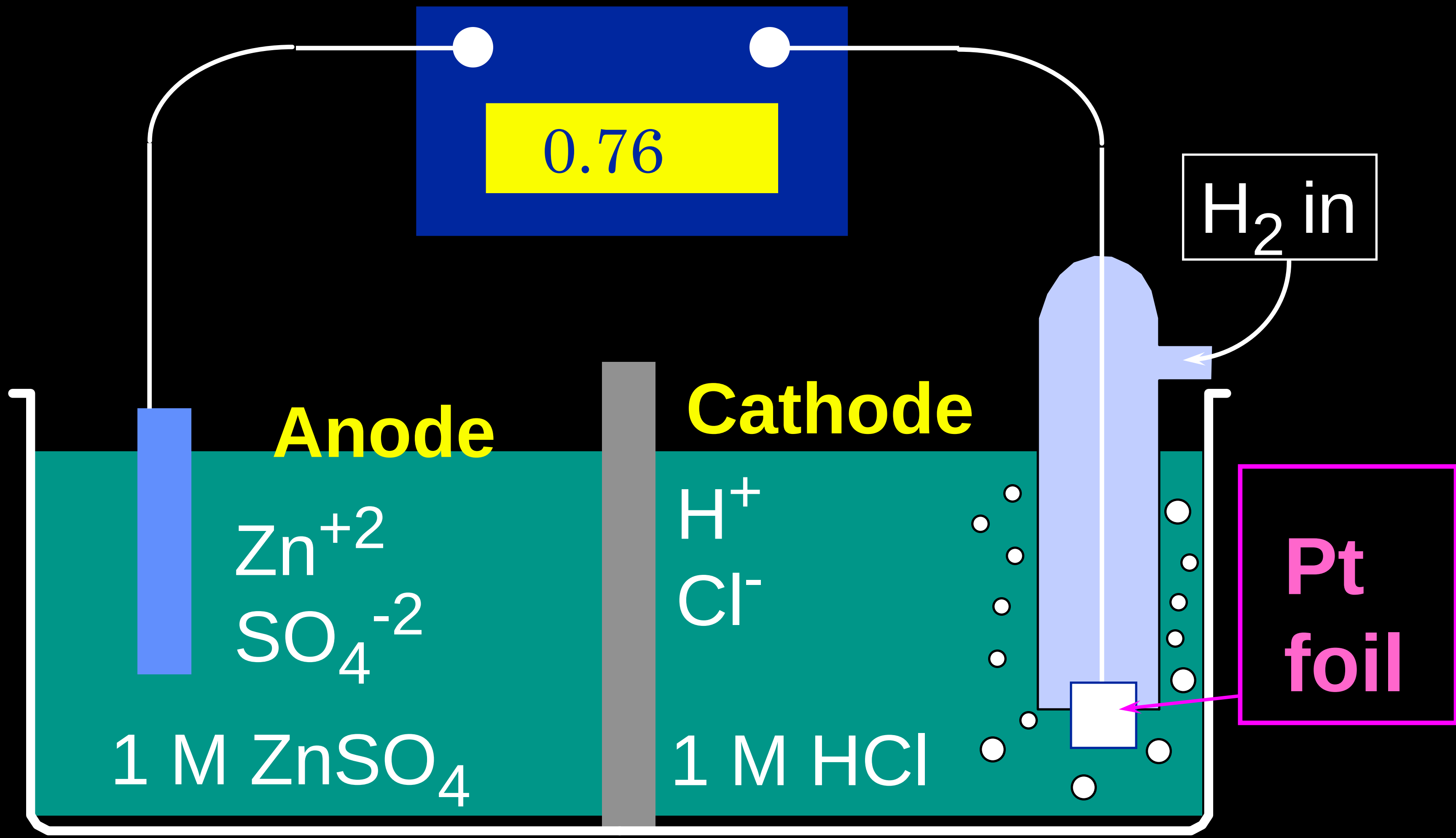
Also called the electromotive force (emf)

Unit is the volt(V)

V = 1 joule of work/coulomb of charge

Measured with a voltmeter

Standard Hydrogen Electrode



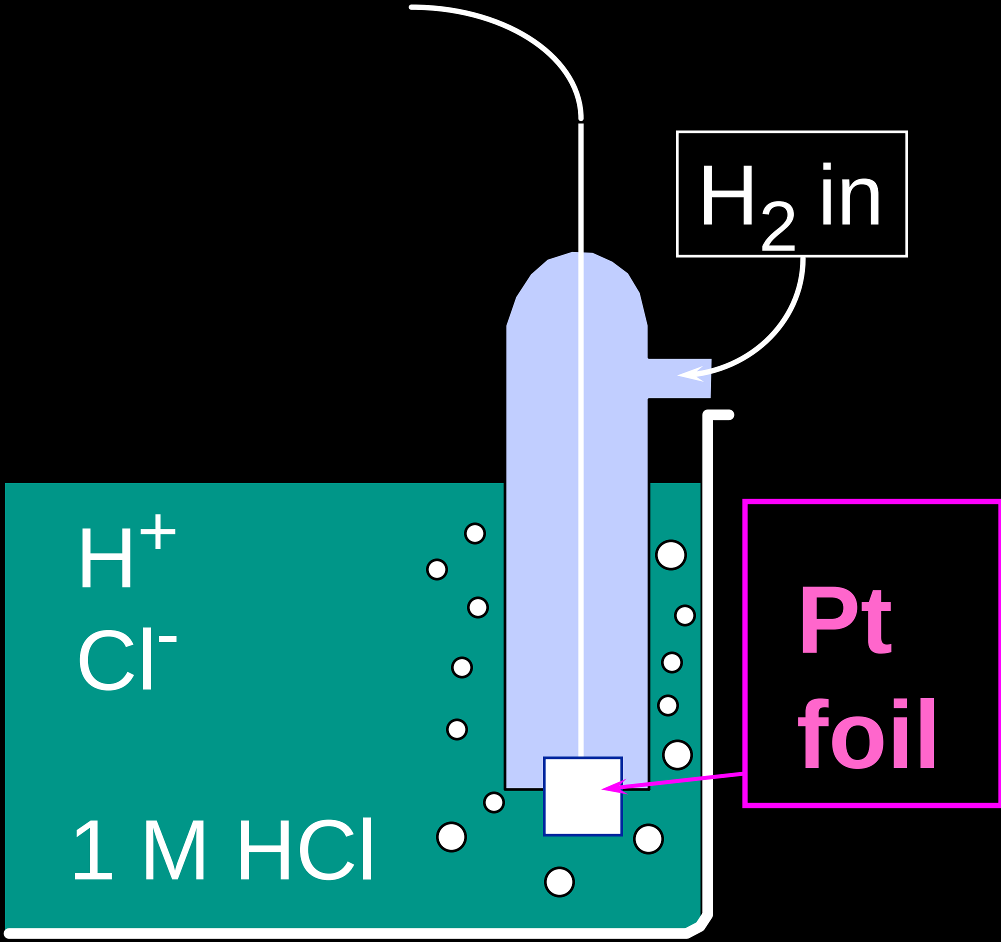
Standard Hydrogen Electrode

This is the reference all other oxidations are compared to

$E^o = 0$

^{o} indicates standard states of 25^{o}C, 1 atm, 1 M solutions.

Can not be produced only theoretical

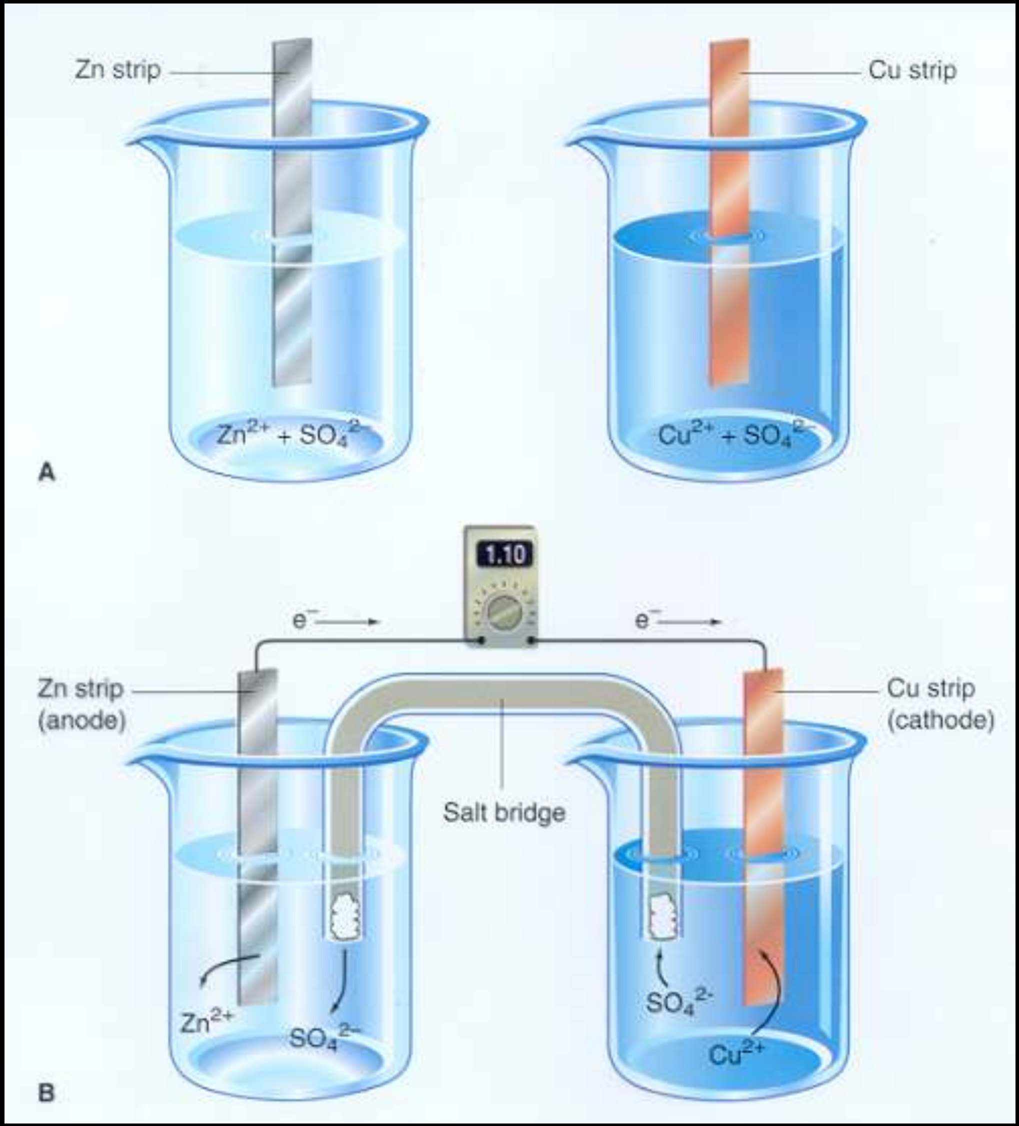


Quick review

Oxidizing agent do what to electrons?

E_{cell} stands for…

Lets see this Happen



In class… then at home.

- Read pages 651-663
- **Complete Concept review 26.1, page 663 #1-4**

Bell Work
29-April-2014

What takes place on the anode side of a voltaic cell? What is a unit for measuring E_{cell}?

Agenda

Calculating E_{cell}

Home Made Batteries

Objective:

You will SEE the result of electrochemistry at work

Home Made Batteries and E_{cell}

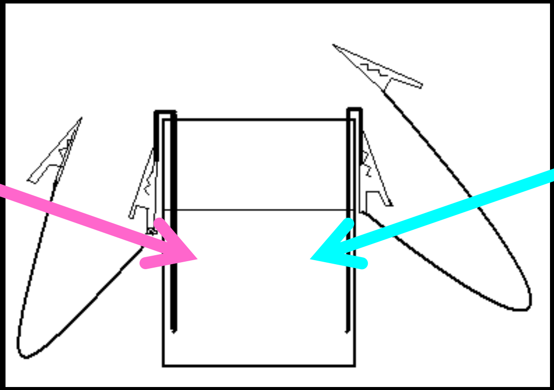
Use the setting of 2V or 2000mV DCV on multimeter

Hold black and red leads to metal electrodes, if negative value switch the leads

Home Made Batteries and E_{cell}

Use leads form Multi Meter to directly connect to anode and cathode

50mL of electrolyte in beaker



100-150mL Beaker

-Rinse electrode between uses

-<u>Return electrolyte</u> solution to stock bottles when finished.

Bell Work
30-April-2014

When 0.4g of Fe^{2+} is oxidized by MnO_4^-, producing Mn^{2+} and Fe^{3+} as we saw in our titration lab last week, how many moles of e^- where exchanged?

(hint: stiochiometry)

Calculating plating

Have to count charge.

Measure current I (in amperes)

1 amp = 1 coulomb (C) of charge per second

$q = I \times t$ q = quantity of electricity

q/F = moles of metal

$F = 96{,}484 \text{ C mol}^{-1}$

Cell Potential

The total cell potential is the sum of the potential at each electrode.

$$E^o_{cell} = E^o_{anode} + E^o_{cathode}$$

$$E^o_{cell} = E^o_{oxidation} + E^o_{reduction}$$

We can look up reduction potentials in a table.

One of the rxns must be reversed, so change its sign.

Cell Potential

$Zn(s) + Cu^{+2}(aq) \rightarrow Zn^{+2}(aq) + Cu(s)$

The total cell potential is the sum of the potential at each electrode.

$$E^o_{cell} = E^o_{Zn \rightarrow Zn^{+2}} + E^o_{Cu^{+2} \rightarrow Cu}$$

Lets look up reduction potentials in a table.

Table 26.1 (page 667)

Remember one of the rxns must be reversed, so change it's sign.

Cell Potential

$Zn(s) + Cu^{+2}(aq) \rightarrow Zn^{+2}(aq) + Cu(s)$

$$E^o_{cell} = E^o_{Zn \rightarrow Zn^{+2}} + E^o_{Cu^{+2} \rightarrow Cu}$$

$$E^o_{cell} = 0.762 + 0.340$$

$$= 1.102V$$

Cell Potential

What are the Eº for the following rxns? Be sure the sign is correct.

$Cu^{+} + e^{-} \rightarrow Cu$

$Pt \rightarrow Pt^{+2} + 2e^{-}$

$Ni \rightarrow Ni^{+2} + 2e^{-}$

Cell Potential

Determine the cell potential for a galvanic cell based on the redox rxn.

$Cu(s) + Fe^{+3}(aq) \rightarrow Cu^{+2}(aq) + Fe^{+2}(aq)$

$Fe^{+3}(aq) + e^{-} \rightarrow Fe^{+2}(aq)$ $E^{o} = 0.77\ V$

~~$Cu^{+2}(aq) + 2e^{-} \rightarrow Cu(s)$ E^{o}~~ $= 0.34\ V$

$Cu(s) \rightarrow Cu^{+2}(aq) + 2e^{-}$ $E^{o} = -0.34\ V$

Line Notation

solid | Aqueous || Aqueous | **solid**

Anode on the left || Cathode on the right

Single line different phases.

Double line porous disk or salt bridge.

If all the substances on one side are aqueous, a platinum electrode is indicated.

For the last rxn

Cu(s) | Cu^{+2}(aq) || Fe^{+2}(aq),Fe^{+3}(aq) | Pt(s)

Practice

The standard reduction potentials of Cu^{2+} and Ag^{+} in soultion are +0.34 and +0.80, respectively. Determine the value of *E* in volts for the following cell at 25°C.

$Cu \mid Cu^{2+} \parallel Ag^{+} \mid Ag$

What is E° for the following?

1. $Sn^{2+} + H^+ \rightarrow Sn^{4+} + H_2$

2. $Ag + Sn^{4+} \rightarrow Ag^+ + Sn^{2+}$

3. $Au + Fe^{3+} \rightarrow Au^+ + Fe^{2+}$

4. $Al + O_2 \rightarrow Al^{3+} + H_2O$

At home.

Read pages 665-671

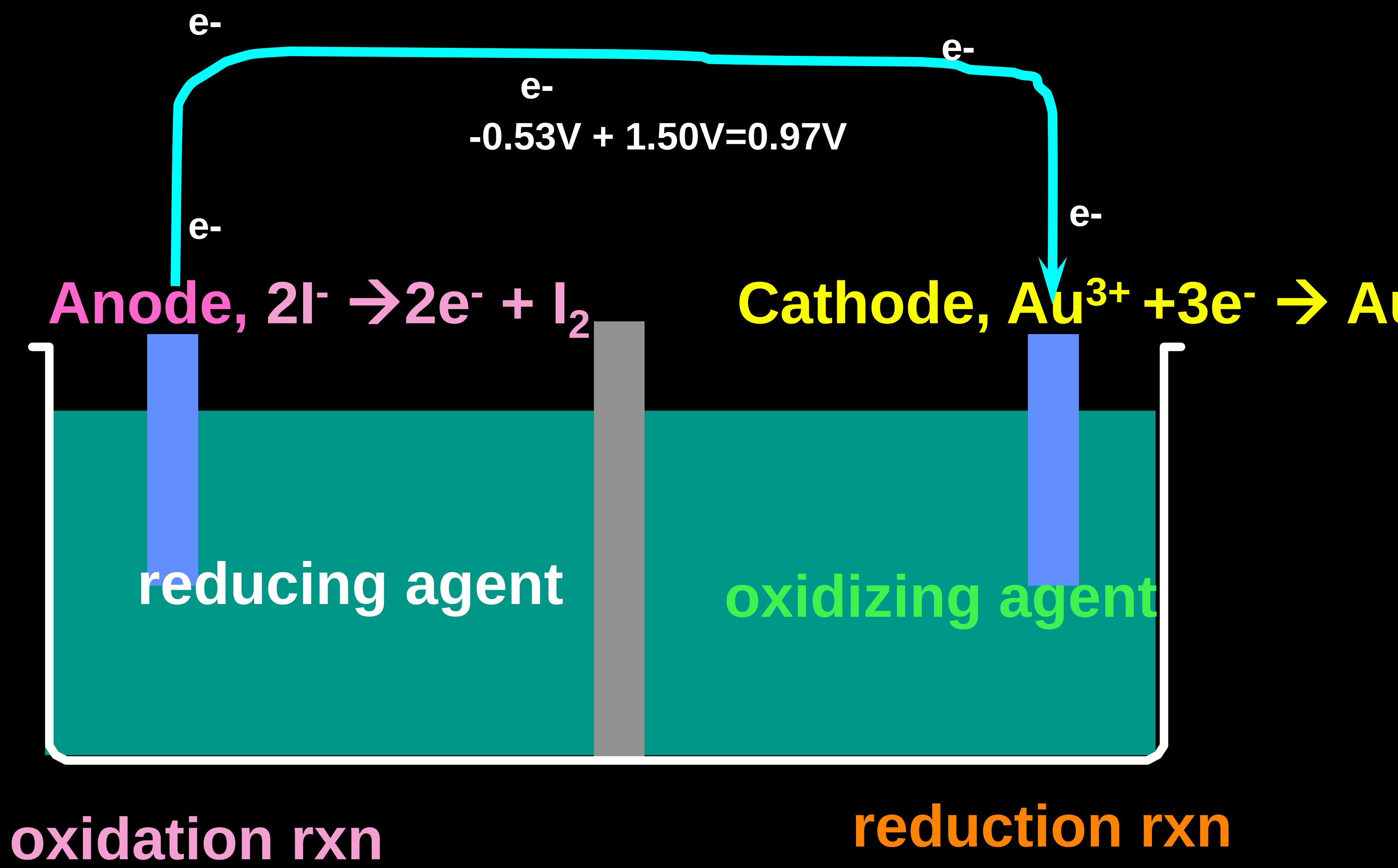
HW Page 670 #10a,b,c

Bell Work 1-May-2014

Complete the below voltaic cell by drawing in and labeling the following: Anode, Cathode, oxidation rxn, reduction rxn, reducing agent, oxidizing agent, and direction of electron flow

Use Au and I_2 as electrodes

Bell Work solution



Galvanic Cell

The rxn always runs spontaneously in the direction that produced a **positive cell potential**.

Four things for a complete description.

1) Cell Potential
2) Direction of flow
3) Designation of anode and cathode
4) Nature of all the components- electrodes and ions

Practice

Completely describe the galvanic cell based on the following half-rxns under standard conditions (draw it out!).

$MnO_4^- + 8\ H^+ \rightarrow Mn^{+2} + 4H_2O$ $E^o = 1.51V$

$Fe^{+3} + 3e^- \rightarrow Fe(s)$ $E^o = -0.036V$

And More Practice

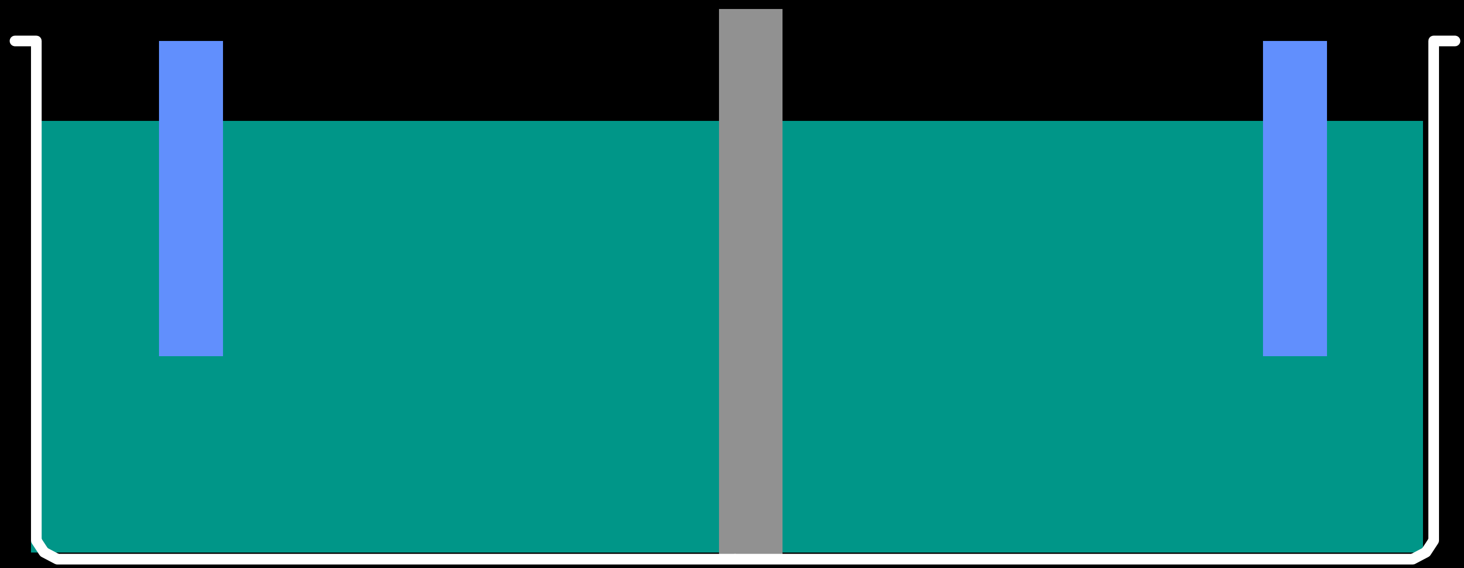
Using the standard reduction potentials, calculate the electromotive force (emf) for the following rxn:

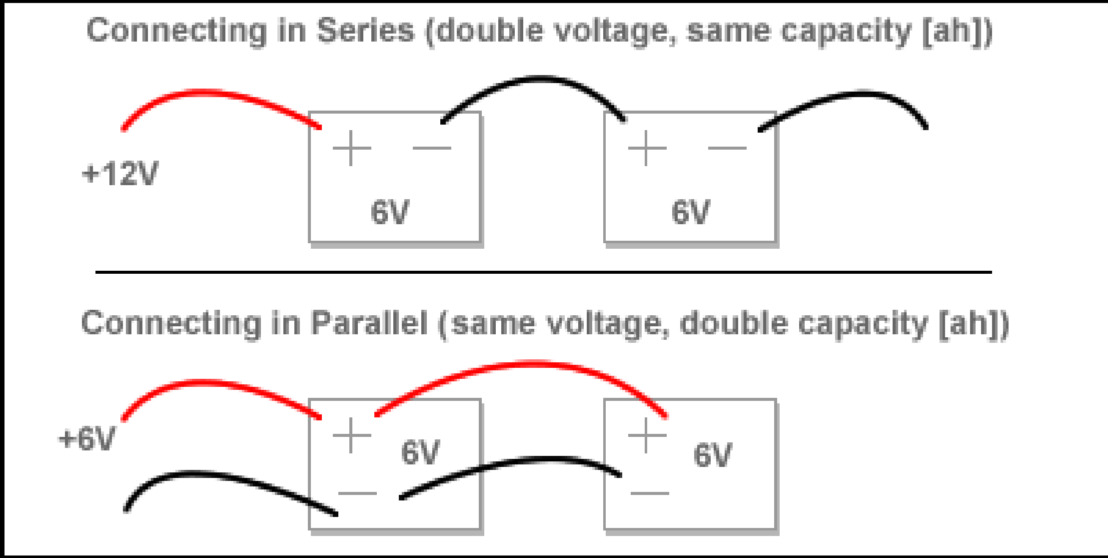
$Zn(s) + Sn^{2+}(aq) \rightarrow Zn^{2+}(aq) + Sn(s)$

Bell Work 2-May-2014

Draw a complete Voltaic cell between the metals Al and Fe. Make sure to label all the parts of the cell and calculate the theoretical cell potential. (Hint: use your standard reduction table on 667 to determine the anode and cathode)

Bell Work




Connecting in Series (double voltage, same capacity [ah])
+12V
6V
6V
Connecting in Parallel (same voltage, double capacity [ah])
+6V
6V
6V